Magnetic Particle Imaging (MPI) for NMR and MRI researchers.

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Public Summary:
Magnetic Particle Imaging (MPI) is a new tracer imaging modality that is gaining significant interest from imaging researchers. MPI uses many of the same hardware and imaging concepts that are familiar to MRI (Magnet Resonance Imaging) and NMR (Nuclear Magnetic Resonance) researchers. However, MPI is much safer for humans than iodine or gadolinium, used in many of MRI and NMR scans, especially for Chronic Kidney Disease (CKD) patients. The weak kidneys of CKD patients cannot safely excrete iodine or gadolinium, leading to increased morbidity and mortality after iodinated X-ray or CT angiograms, or after gadolinium-MRA studies. Iron oxides, on the other hand, are processed in the liver, and have been shown to be safe even for CKD patients. Also, even prototype MPI scanners can already achieve fast. high-sensitivity, and high-contrast angiograms with millimeter-scale resolution. Moreover, MPI shows great potential for an exciting array of applications, including stem cell tracking in vivo, first-pass contrast studies to diagnose or stage cancer, and inflammation imaging in vivo. So far, only a handful of prototype small-animal MPI scanners have been constructed worldwide. Hence, MPI is open to great advances, especially in hardware, pulse sequence, and nanoparticle improvements, with the potential to revolutionize the biomedical imaging field.

Scientific Abstract:
Magnetic Particle Imaging (MPI) is a new tracer imaging modality that is gaining significant interest from NMR and MRI researchers. While the physics of MPI differ substantially from MRI, it employs hardware and imaging concepts that are familiar to MRI researchers, such as magnetic excitation and detection, pulse sequences, and relaxation effects. Furthermore, MPI employs the same superparamagnetic iron oxide (SPIO) contrast agents that are sometimes used for MR angiography and are often used for MRI cell tracking studies. These SPIOs are much safer for humans than iodine or gadolinium, especially for Chronic Kidney Disease (CKD) patients. The weak kidneys of CKD patients cannot safely excrete iodine or gadolinium, leading to increased morbidity and mortality after iodinated X-ray or CT angiograms, or after gadolinium-MRA studies. Iron oxides, on the other hand, are processed in the liver, and have been shown to be safe even for CKD patients. Unlike the "black blood" contrast generated by SPIOs in MRI due to increased T(2)(*) dephasing, SPIOs in MPI generate positive, "bright blood" contrast. With this ideal contrast, even prototype MPI scanners can already achieve fast, high-sensitivity, and high-contrast angiograms with millimeter-scale resolutions in phantoms and in animals. Moreover, MPI shows great potential for an exciting array of applications, including stem cell tracking in vivo, first-pass contrast studies to diagnose or stage cancer, and inflammation imaging in vivo. So far, only a handful of prototype small-animal MPI scanners have been constructed worldwide. Hence, MPI is open to great advances, especially in hardware, pulse sequence, and nanoparticle improvements, with the potential to revolutionize the biomedical imaging field.